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Abstract

THE OAK RIDGE HIGH FLUX ISOTOPE REACTOR

John A. Swartout (Oak Ridge National Laboratory)
A. L. Boch (Oak Ridge National Laboratory)
T. E. Cole (Oak Ridge National Laboratory)
R. D. Cheverton (Oak Ridge National Laboratory)
G. M. Adamson (Oak Ridge National Laboratory)
C. E. Winters (Parma Research Center)

The High Flux Isotope Reactor (HFIR), now being constructed at the Oak Ridge National Laboratory, is designed primarily for the production of macro-quantities of transplutonium elements. Versatility for research is provided by inclusion of beam tubes, irradiation facilities, a variety of reflector through-holes and provision for hydraulic rabbit tubes.

The reactor is of the "flux trap" type with normal water in the central moderator-reflector trap. Because of the sensitivity of transplutonium isotope production rates to thermal-neutron flux, the design of the core was dictated by the requirement for the highest practical thermal neutron flux in the plutonium target. The average thermal-neutron flux in a 300-gram Pu-242 target is estimated to be 2 - 3 x 10^{15} n/cm^2.sec with a maximum unperturbed flux of about 5 x 10^{15} at the design power of 100 Mw(th). This high flux was obtained by optimizing the size of the island, by making the fuel region as compact as possible and the metal-to-water ratio as large as possible within limitations set by heat-removal considerations, and by reducing the ratio of maximum to average power density.

The fuel is highly enriched (93%) U-235 contained in essentially one fuel assembly consisting of two concentric annuli of involute-shape plates. The dimensions of the active portion of the cylindrical core are 5.6 in. (14.2 cm) inner diameter, 16.5 in. (41.9 cm) outer diameter and 20 in. (50.8 cm) high. The plates contain U_3O_8 in an aluminum matrix, clad with aluminum. Heat is removed by pumping about 15 000 gal(US)/min. of normal water under

600 lb/in.^{2} (42.2 kg/cm^2) pressure to produce a coolant velocity of 42 ft/sec (10.7m/sec) downward between the plates. The average and hot-spot maximum heat fluxes are 8 x 10^5 and 2 x 10^6 Btu/h.ft^2, respectively. A cylindrical beryllium reflector surrounds the fuel. With a fuel loading of 9.4 kg of U-235 the average fuel cycle time will be about 15 days.

The ratio of maximum to average power density is held to about 1.5, excluding hot-spot effects, by (1) cylindrical core geometry; (2) reflector control in the form of two concentric, oppositely driven, cylindrical control plates located in the annulus between the fuel and the beryllium reflector and containing an axially graded poison; (3) extending the non-fuel-bearing portions of the fuel plates; (4) radially graded fuel concentration in the plates; and (5) inclusion of radially graded burnable poison in the plates. An extensive investigation was made of means to increase the ratio of surface area to volume and to increase the maximum permissible heat flux. Included were analyses and measurements of fuel-plate strength, burnout behavior, aluminum-oxide formation rates and effects on heat transfer, fabrication tolerances, control-system characteristics and the elimination of side-plates in the annular fuel assembly.

Critical experiments have verified the calculated value of 5 x 10^{15}n/cm^2.sec for the maximum thermal-neutron flux at 100 MW. Based on fuel-element development and the fabrication of test cores, it is believed that the necessary close dimensional and fuel-distribution tolerances will be achieved.

The reactor will be completed and operation started during 1965. The cost of the reactor including building and auxiliary facilities will be slightly less than \$15 x 10^6.